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ABSTRACT

During paroxysms of colic, infants are hypertonic or neurolabile, and appear to be in acute, abdominal pain. The infant lets out a high-pitched cry which soon reaches a screaming level, and which is coupled with facial grimacing. The infant is difficult to console, and may resist attempts to sooth it. Between spells, these infants cry normally and are not hypertonic. Recent research suggests that infants with true colic represent a subgroup of infants with excessive crying. Findings indicate that colic and excessive crying can be differentiated by physical and behavioral criteria. Mothers of infants with colic perceive their infant's cry as being different from that of other infants, and rate their infants as having a difficult temperament. From a pediatric point of view, colic appears to be an imbalance of the autonomic nervous system, particularly of the dynamic interplay between sympathetic and parasympathetic systems. From a developmental point of view, this autonomic imbalance could be related to the broad spectrum of changes in neurological and behavioral function that occur around the second month: the so-called biobehavioral shift from basic physiological regulation to the beginnings of social regulation. What is triggered by crying as a biologically based condition may develop into crying as mediated by social-emotional factors in the parents. (RH)

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**PRELIMINARY DRAFT**

# COLIC FOR DEVELOPMENTALISTS

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PRESENTED IN COLLABORATION BETWEEN CHILD DEVELOPMENT AND PEDIATRICS: THE CASE OF INFANT COLIC, B.M. LESTER (CHAIR), INVITED SYMPOSIUM, MEETING OF THE SOCIETY FOR RESEARCH IN CHILD DEVELOPMENT, KANSAS CITY, APRIL 27-30, 1989.



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# INTRODUCTION

This symposium is being sponsored as part of the SRCD liaison activities with pediatrics. The idea of a liaison with pediatrics was developed to facilitate interdisciplinary activity between the fields of child development and pediatrics. One of the possible ways to facilitate interdisciplinary work is to sponsor joint symposia on topics selected to highlight the values of collaborative efforts between our two disciplines. For todays symposium we have chosen a topic that is particularly ripe for interdisciplinary collaboration; for colic is a serious, if not bewildering, pediatric problem. It is also an opportunity to study the interplay of developmental issues that involve parent infant relationships, the biological basis of behavior including CNS maturation, temperament, sleep state organization, and crying.

We are very fortunate to have with us today, three distinguished pediatricians. Bill Carey, Ron Barr and Berry Brazelton are well known in the field of child development; their

work represents the kind of interdisciplinary cross fertilization that we are trying to endorse and promote.

## COLIC FOR DEVELOPMENTALISTS

Colic is an area that has been of little interest to developmentalists. In pediatrics, where most of the work has taken place, colic enjoys a mixed reputation. On the one hand it is recognized as an important clinical problem - upwards of 30% of normal healthy infants are reported to have colic in the first 6 months of life and is it well appreciated that having a colicky baby can be extremely stressful on the entire family. On the other hand , as a clinical problem, colic is somewhat of a curiosity because it is not associated with a known mortality or obvious morbidity; it is a condition that is traditionally thought of as transitory or self-limiting: Hence the conventional wisdom, "he'll out grow it, it'll go away by itself." There are, in fact, no prospective longitudinal studies of infants with colic; the few retrospective studies that are available do not generate a clear picture of sequelae. After more than 80 years of inquiry, colic remains a poorly understood syndrome. The literature on colic is extensive with opinion but little is actually known about the

etiology or pathophysiology of this condition. The term colic is ambiguous, vague and loosely applied by parents and clinicians. Amidst the substantial disagreements there is general agreement that both the scientific study and clinical management of colic are hampered by the absence of a standard definition and accepted diagnostic criteria.

From a developmental point of view, colic provides the opportunity to study some interesting issues. While colic may be self limiting, it is not necessarily limited to "self." Colic is a problem having to do with extreme crying that may be biologically based; it is also an issue for the parent infant relationship. As a relationship problem, colic may have consequences for the infant's development after the crying stops.

One thing we know for certain is that colic has to do with crying, long periods of unexplained crying in otherwise, normal healthy infants. Colic has been equated with excessive crying. From this perspective probably the most currently accepted definition of colic is that provided by Wessel "one who is

otherwise healthy and well fed had paroxysms of irritability, fussing or crying lasting for a total of more than 3 hours a day and occurring on more than 3 days in any one week and that the paroxysms continued to occur for more than 3 weeks."

However, there is more to colic than just excessive crying. From the clinical literature, we can describe a second set of characteristics that refer to an apparent pain/symptom complex in the colicky infant. During these paroxysms which appear as sudden attacks or fits, but not at other times, affected infants are hypertonic or neurolabile and appear to be in acute, abdominal pain. The term "colic," from "colon" is based on the notion that the symptoms result from vigorous gastrointestinal contractions. During a paroxysm the infant suddenly begins to cry. The cry is described as high pitched, reaches a screaming level, and the sound of the cry coupled with facial grimacing indicates that the infant is in severe pain. Associated with the onset of crying there is increased motor activity, flexion of the elbows, clenched fists, generalized hypertonicity of musculature,

the knees are drawn up or stiff and extended, the abdominal wall is tense and the abdomen may become distended. Eyes may be tightly closed or opened wide, the back is arched, face is red, feet are cold, and brief periods of breath holding have been observed. Bowel sounds are increased and there is considerable gas. The infant is difficult if not impossible to console, and may resist or struggle with attempts to sooth. Between spells, these infants have a normal cry and are not hypertonic.

We think that these clinical signs describe infants with true colic who represent a subgroup of infants with excessive crying. Colic and excessive crying are not the same; infants with colic can be distinguished from infants with excessive crying based on the physical and behavioral criteria shown in slide 1.

## SLIDE 1 HERE

Infants with colic first meet the criteria for excessive crying but, in addition, there is a paroxysmal attack like quality to the onset of the episode, the cry is distinctive, high pitched and sounds as if the infant is in pain, the infant shows physical signs associated with hypertonia and is inconsolable.

We conducted a preliminary study in which mothers currently participating in a longitudinal study of development in term and preterm infants were sent letters explaining that we were interested in colic. Mothers who reported having colicky infants were interviewed by phone to determine if their infants fit these hypothesized criteria for colic. We identified 16 infants who met this criteria between 1 and 4 months of age.

SLIDE 2 HERE

The characteristics of these infants are shown in this slide. Control infants were selected from the same longitudinal data base and matched using the criteria shown in this slide.

The cries of these infants were recorded at 1 month of age and analyzed using our computer based, digital signal processing cry analysis system. Approximately 30 sec of crying was analyzed for each infant.

SLIDE 3 HERE

**This slide shows the mean fundamental frequency or average pitch of the cry in the colic and control infants. As shown in the slide, infants with colic had a higher pitched cry than the group of matched controls.**

**SLIDE 4 HERE**

**This slide shows the range of the fundamental frequency or the variability in the pitch of these cries. The cries of infants with colic show more variability in pitch than the cries of the controls.**

SLIDE 5 HERE

**This slide shows the percentage dysphonation which is the amount of turbulence or noise quality in the cry. The cries of infants with colic show more dysphonation than the cries of infants in the control group.**

## SLIDE 6 HERE

**This slide shows the cry analysis of a single infant with colic. Areas of high pitch are darkened and areas of dysphonation are cross-hatched. This infant has periods when 40-60% of the cry is high pitched with over 20% dysphonation. It is not hard to imagine how a cry with these sound characteristics that lasted several hours a day for several weeks could be disturbing to parents. How do parents react to these cries?**

SLIDE 7 HERE

Following the recording of the cry we asked the mothers to rate this same cry on a series of 7 point rating scales developed by Zeskind and Lester that have been used in other studies. The mother completes the rating scales after listening to the cry through headphones. The scales measure how mothers perceive or react to their infants cry. As shown in this slide, mothers of colicky infants rated the cries of their infants as sounding more urgent, more piercing, more grating, more arousing and the mothers felt more sad listening to the cry than did mothers of control infants.

SLIDE 8 HERE

At 3 months of age the mothers filled out the Bates Infant Characteristics Questionnaire. As shown in this slide, mothers of infants with colic rated their infant as having a more fussy-difficult temperament than mothers of controls.

This small study illustrates that infants with colic do have a different sounding cry, their mothers perceive the cry as different, and not surprisingly, rate their infants as difficult temperament. Similar temperament finding have been previously reported by Carey and others.

Our hypothesis is that these infants with colic can be distinguished from infants with excessive crying. Brazelton had previously reported that by 6 weeks of age about 25% of infants cry more than 2 3/4 hours a day. These are probably infants with excessive crying. Excessive crying falls at the upper quartile of the distribution reported by Brazelton. Colic, as we describe it, is a subgroup of these infants and only occurs in about 8% of the population. These are infants with excessive crying who also

show the additional criteria of paroxysmal onset, high pitched pain cry, hypertonia and inconsolability.

In our view, underlying colic is an imbalance of the autonomic nervous system, an imbalance in the dynamic interplay between the sympathetic and parasympathetic systems. In response to stimulation, sympathetic activity is greatly exaggerated while parasympathetic activity is reduced resulting in a dominance of sympathetic over parasympathetic activity. Colicky infants show an extreme aversive reaction to stimulation that other infants do not experience as aversive. The heightened sympathetic/low parasympathetic response to stimulation or sympathetic dominance, triggers the sudden onset, high pitched pain cry and hypertonia. The infant lacks self regulatory capacities for soothing and is unable to benefit from caregiver attempts at soothing and the infant becomes inconsolable.

These physiological changes may be mediated, in part, by the vagal complex which affects the acoustic characteristics of the cry and provides CNS input to the stomach. Tachyastria or

increased stomach contractions occur when vagal input to the stomach is reduced and sympathetic activity is increased. It is noteworthy that over 50 years ago the term vagotonia was used to explain an imbalance of the autonomic nervous system thought to underlie hypertonia. The vagal complex may provide the neurophysiological link to explain simultaneous changes in the gut and cry associated with colic.

Hypertonicity has also been described as a behavioral feature of difficult temperament that may mediate colic. It is also interesting that sleep disturbances have been found in infants with colic. Weissbluth suggests that colic reflects a disturbance in the orderly development of arousal/inhibition or sleep wake control mechanisms, a view compatible with the notion of autonomic imbalance.

From a developmental point of view it is also interesting to speculate that this autonomic imbalance could be related to the broad spectrum of changes in neurological and behavioral function that occur around the second month, the so-called

biobehavioral shift from basic physiological regulation to the beginnings of social regulation.

The view that colic is biologically based is not meant to diminish the role of parenting. From a transactional perspective, it makes sense that parental characteristics will determine how parents behave toward their crying infant which will, in turn, affect the infant's behavior. This may exacerbate the crying as well as affect the developing parent infant relationship. Mothers of infants with excessive crying have been reported as depressed, exhausted and angry and are less positive during interaction with their infants than controls. Colic also begins at a time when parents are expecting a change from an essentially helpless newborn to a more apt social partner. Such a violation in parents expectations is a transactional event that could contribute to difficulties in the developing parent infant relationship. Thus, what is triggered by crying as a biologically based condition may develop into crying as mediated by social-emotional factors in the parents. Colic may have longer term

effects on parenting; for example, on the parent infant attachment relationship well after the colic ends.

Colic is an area at the intersection of child development and pediatrics that has much to offer the study of developmental process. Such study would, in turn, contribute to our understanding and perhaps management of this serious pediatric problem that affects the entire infant family system.

## CRITERIA FOR COLIC

- INFANT FIRST MEETS CRITERIA FOR EXCESSIVE CRYING:
  CRYING FOR AT LEAST 3 HOURS PER DAY
  3 DAYS A WEEK AND FOR 3 WEEKS
- IN ADDITION INFANT SHOWS FOLLOWING:
  CRYING DESCRIBED AS PAROXYSMAL OR SUDDEN ONSET
  DURING COLIC INFANT SHOWS DISTINCTIVE, HIGH PITCHED PAIN CRY
- INFANT SHOWS PHYSICAL SIGNS ASSOCIATED WITH HYPERTONIA
- INFANT IS DIFFICULT TO CONSOLE

## COLIC SAMPLE

## (N=16)

7 TERM

9 PRETERM

BIRTHWEIGHT <1750 GRAMS

<35 WEEKS GESTATIONAL AGE

4 HEALTHY

3 NEONATAL RESPIRATORY PROBLEMS

2 NEONATAL RESPIRATORY PROBLEMS AND IVH I OR II

## MATCHED CONTROLS

## (N=16)

MATCHING CRITERIA

INFANT FROM SAME LONGITUDINAL DATA BASE

INFANT NOT FIT COLIC CRITERIA

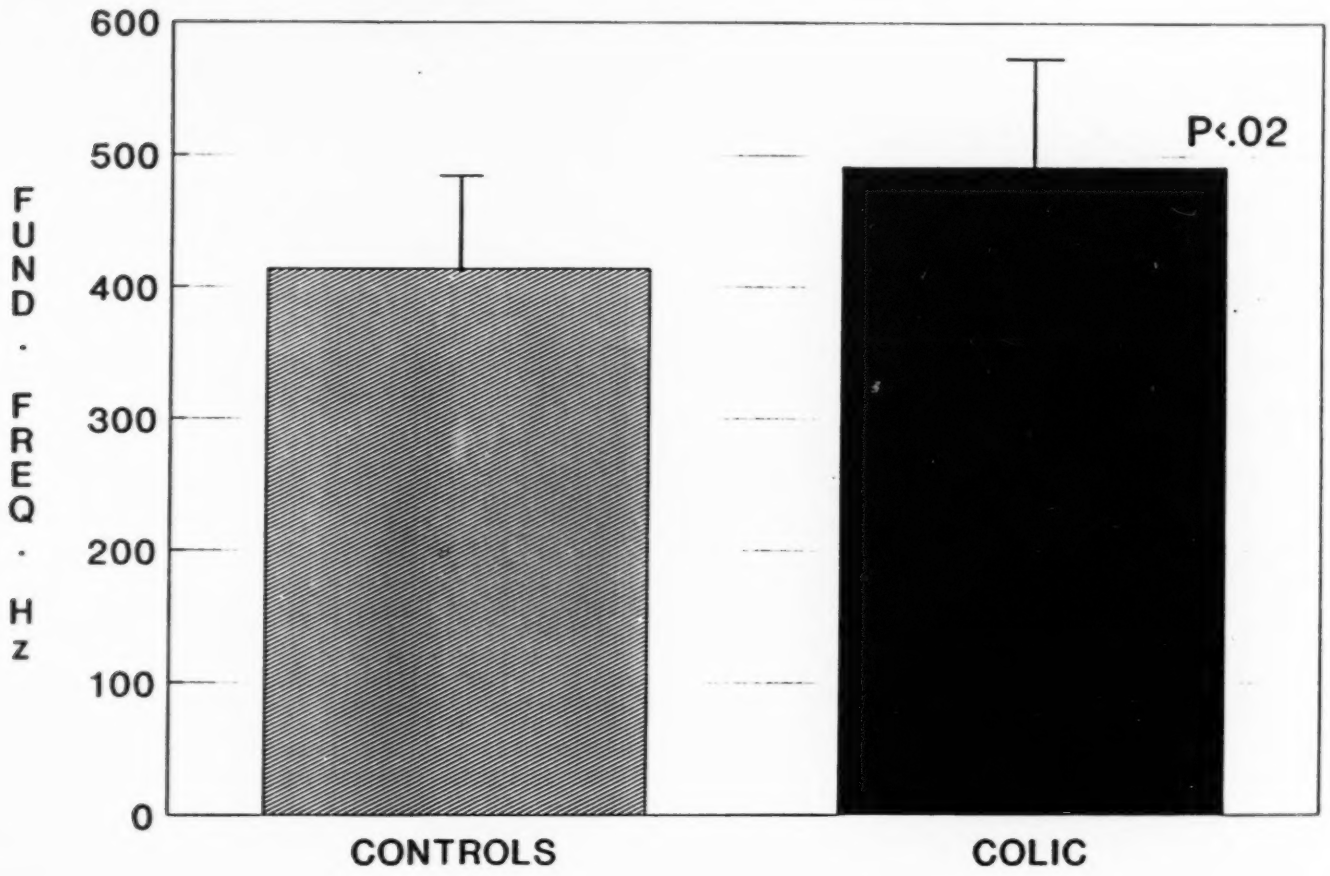
GESTATIONAL AGE AT BIRTH WITHIN 1 WEEK

BIRTHWEIGHT WITHIN 200 GRAMS

SAME TYPE ILLNESS OR INSULT

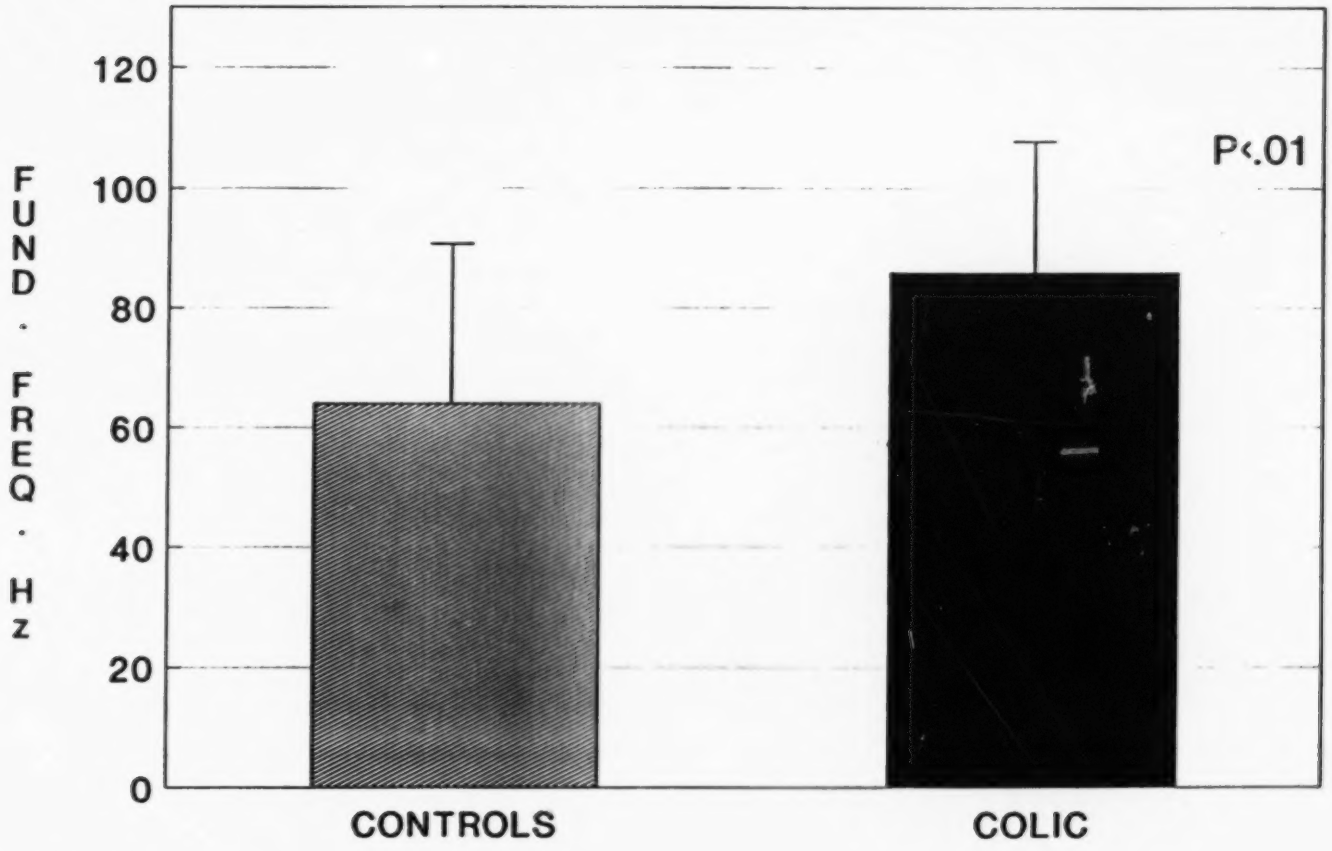
SLIDE 3

# AVERAGE FUNDAMENTAL FREQUENCY OF CRY IN INFANTS WITH COLIC AND CONTROLS



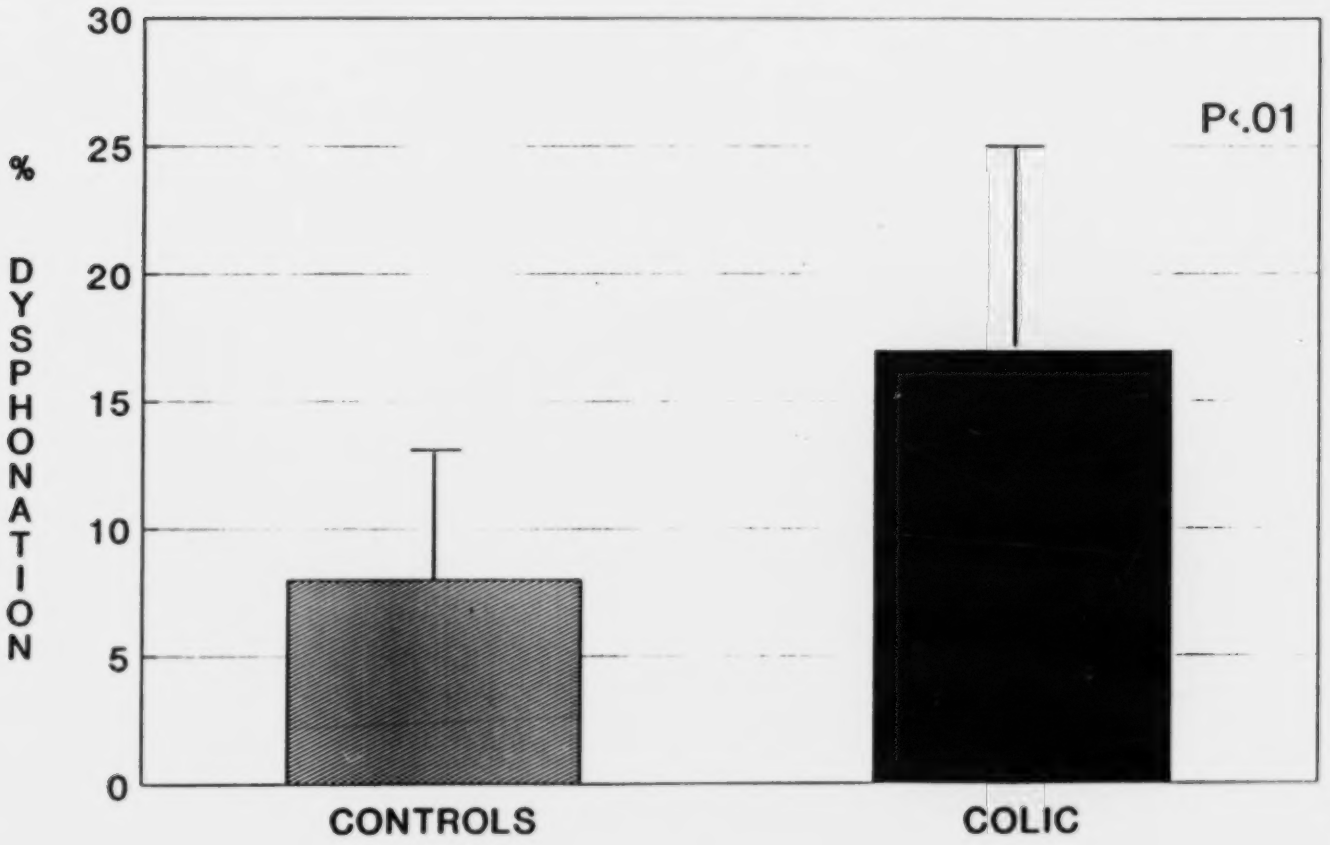
SLIDE 4

# RANGE OF FUNDAMENTAL FREQUENCY OF CRY IN INFANTS WITH COLIC AND CONTROLS

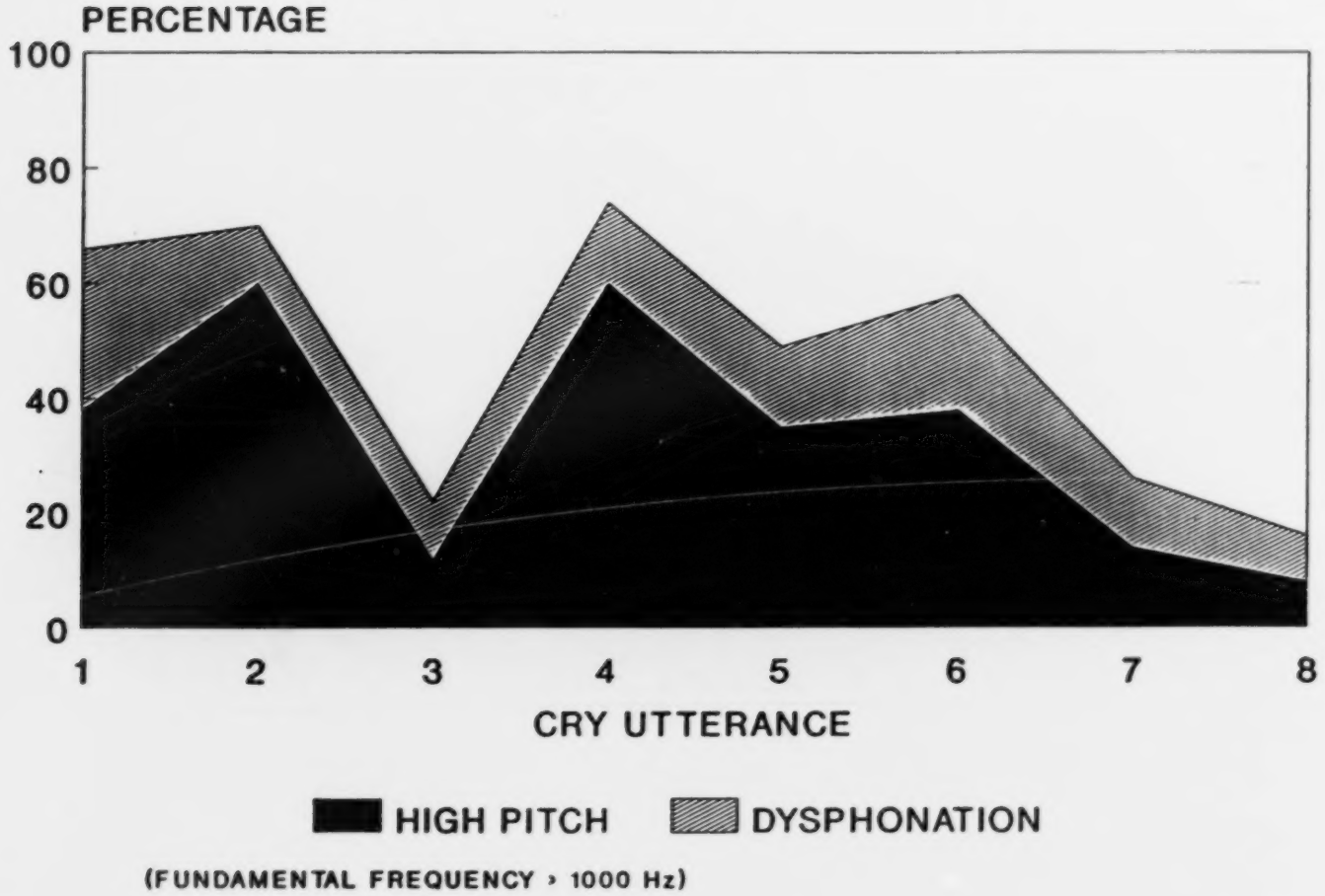


SLIDE 5

# AVERAGE PERCENT DYSPHONATION IN CRY OF INFANTS WITH COLIC AND CONTROLS



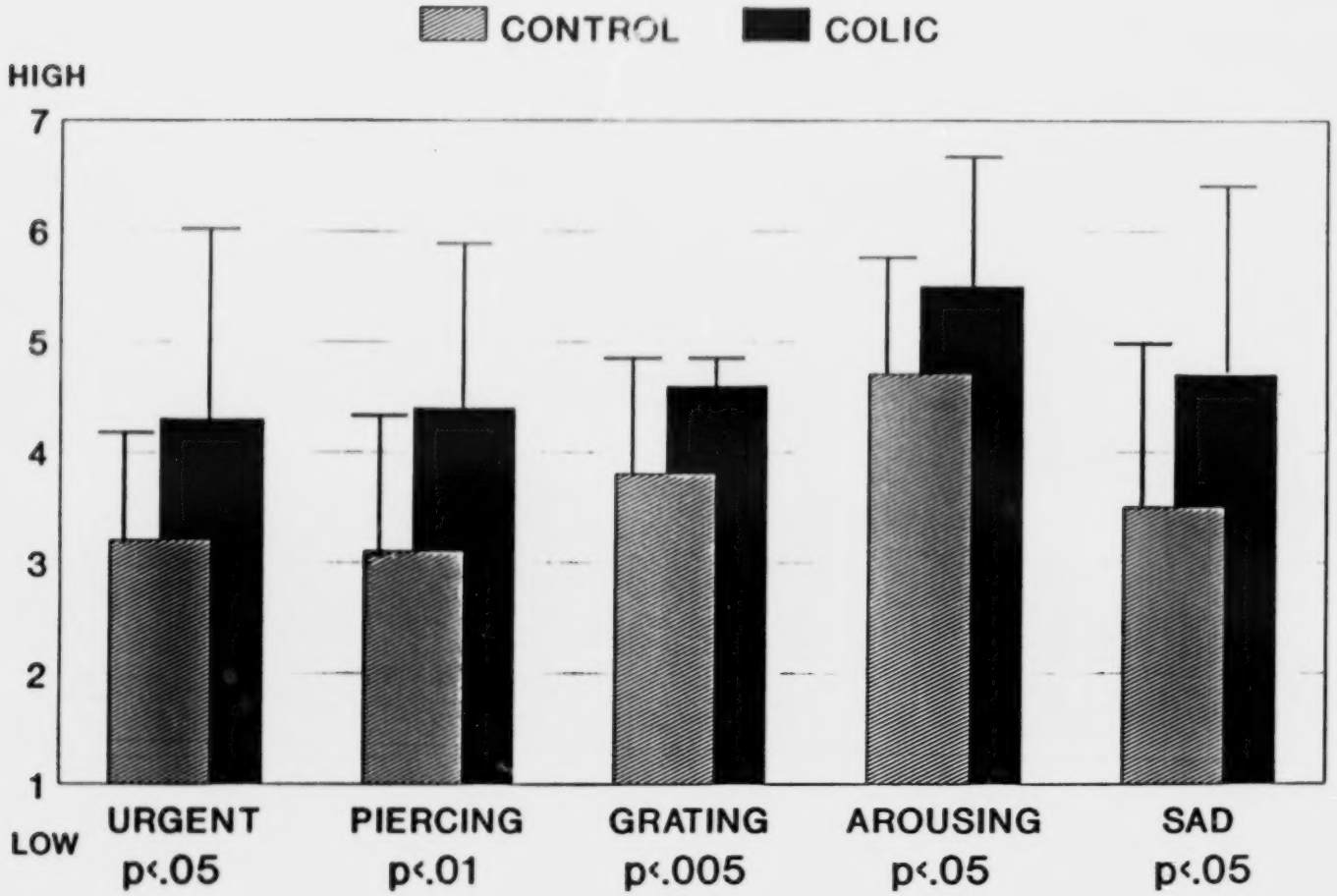
# INFANT WITH COLIC
# CRY CHARACTERISTICS




SLIDE 6

SLIDE 7

# MATERNAL CRY PERCEPTION RATING OF INFANTS WITH COLIC AND CONTROL



SLIDE 8

# FUSSY-DIFFICULT TEMPERAMENT RATING IN INFANTS WITH COLIC AND CONTROLS